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SAFETY CONDITIONS IN LIBERTY MINE, LIBERTY FUEL CO., LATUDA, UTAH

BY

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SAFETY CONDITIONS IN LIBERTY MINE, LIBERTY FUEL COMPANY, LATUDA, UTAH[1]

By D. J. Parker[2]

INTRODUCTION

This report is based on data collected in and about the Liberty mine of the Liberty Fuel Co. by D. J. Parker and W. W. Kessler on December 13 and 14, 1933.

An important phase of an examination to determine the general condition of a mine with respect to safety is the collection of dust samples from rock-dusted areas. Definite conclusions, based on intelligent interpretation of the analyses of such samples, can be reached only when the general condition of the mine is known.

A similar examination and report were made on this property in January 1930 by D. J. Parker and R. I. C. Manning. Since that time much has been done by the management to improve safety conditions in this mine. The changes made will be noted in the course of this report.

The mine is in Spring Canyon at Latuda, Carbon County, Utah, and is served by a branch line of the Denver & Rio Grande Western Railroad about 7 miles long and connecting to the main line near Helper, Utah.

The writer desires to express his sincere appreciation for the many courtesies and helpful cooperation extended by Superintendent George Schultz and Mine Foreman F. W. Koelling.

GEOLOGY

The bed worked is known as the first sub-bed below the Castle Gate, and occurs in the Mesaverde formation of the Upper Cretaceous system; it contains alternate beds of shale, sandstone, and coal, many of which are lenticular. This accounts for the fact that the roof and floor in this field are sandstone in some places and shale in others.

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[1] The Bureau of Mines will welcome reprinting of this paper, provided the following footnote acknowledgment is used: "Reprinted from U. S. Bureau of Mines Information Circular 6812."

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The bed ranges in thickness from 4 to 11 feet and averages about 7½ feet; the dip is approximately 8 percent NE. and strikes NW. and SE; the depth of cover ranges from a few hundred feet to 700 feet.

The presence of "wants" or areas where the coal has pinched out, together with burned-out territory, has made maintenance of systematic development very difficult in some sections of the mine. Elevation of the portal above sea level is 7,903 feet.

GENERAL INFORMATION

The Liberty mine was opened and coal shipments were begun in 1917. At present an average of 80 men is employed. This number, however, varies with seasonal changes of the market. During 1933, 102,945 tons of coal were produced, with 121,533 man-hours of work.

The general topography near Latuda is mountainous; the canyon walls rising rather precipitously on either side; consequently, the possibility of snow slides becomes a matter of grave concern.

SURFACE PLANT AND EQUIPMENT

Tipple

Following opening of the mine in 1917, when difficulties were encountered in obtaining screening equipment because of war-time conditions, a temporary bar screen was erected and used for the first year and a half. As the demand for better preparation increased, a small, wooden, three-track tipple was erected, and equipped with shaker screens for preparing three sizes—8-inch lump, domestic lump, and 3-inch mine run.

With increased competition and demand for improved preparation it became necessary within a short time to make three commercial sizes under the tipple—8-inch lump, domestic lump, and nut—and to convey the minus 1-5/8-coal by conveyor to a rescreening plant which sizes and prepares the straight slack into screen slack and dust, thus allowing 5 sizes to be made simultaneously.

In 1928 a modern, all-steel, four-track tipple was built to replace the old preparation plant. This new tipple has several features which represent a radical departure from general tipple layouts.

Due to limited space only four tracks were built under the new tipple: the slack is conveyed 200 feet down the track to the rescreening plant, which is placed over bins; this permits six sizes to be prepared at the same time.

Because the plant was located alongside the old tipple, only a small amount of grading and new trackwork was necessary, so that the cost was approximately $5,000.00.

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The foundation consists of a series of concrete piers extending down to bedrock from a few feet to 14 feet below ground level.

The cost of the completed plant was as follows:

Foundations, tipple, and bridge approaching dump	$ 7,500.00
Structure and machinery	75,000.00
Original rescreen plant and bins used in connection with new plant	13,000.00
Rescreen-plant additions	3,000.00
Boxcar loader, installed	8,000.00
Total cost of plant	106,500.00

The loaded cars are lowered from the mine by cable onto a double-track bridge.

One car at a time is passed over a mine-car scale with a 10-foot platform where the weight of the coal is recorded on a quick-reading dial, after which it enters a rotary dump with push-button control.

The dump is driven by a two-speed motor with interlocking control panel and is so controlled that the coal is emptied from the car at slow speed. Immediately after the coal is emptied from the mine car the dumping speed is doubled, until the car is again upright; then a solenoid brake on the motor brings the revolving dump to rest in the proper position to take the next load and eject the empty car.

From the dump bin the coal is conveyed to the shaker screens, which are in two sections, with a total length of 60 feet and a width of 6 feet, with 3 decks hung from the main structure by 8 pairs of shaker rods at an angle of 14° conveyed at a speed of 90 r.p.m. by two pairs of excentric belts driven by a 40-hp. motor.

All perforated plates are of the round-hole type 10, 8, 6, 3, and 1-5/8 inches in size and extend across the full width of the screens. There are 16 feet of 8-inch, 16 feet of 3-inch, and 12 feet of 1-5/8-inch perforations.

The different sizes of coal, except the 1-5/8-inch, pass over a degradation screen perforated with 1-5/8-inch round holes before passing to their respective picking tables or loading booms.

The plant is equipped with a double-deck refuse conveyor laced through the horizontal or picking table part of the loading booms. The shale or rock is placed on the top deck and conveyed out beyond the passing track, where it is dropped directly into a railroad car placed on a stub track which is used only for the waste product.

The bottom deck of the refuse conveyor is used to return the best part of the "bony" coal to a crusher located over a 30-ton bin at the rear of the shaker screens. After being crushed to 3-inch size, this bony coal is taken out of the bin and elevated to a point where it is fed onto the screens again to be picked and a large part recovered in the nut and slack sizes.

One Manierre extension-type boxcar loader with a capacity of 200 tons per hour is provided for loading boxcars. The tipple is so arranged that any size or combination of sizes may be taken to the boxcar loader.

This is accomplished by means of a transverse conveyor running along the ends of the loading booms. This conveyor is reversible, and when any particular size of coal is to be loaded into boxcars the boom which carries that particular size is so elevated that it discharges into the transverse conveyor, whence it is carried on a small traveling boom directly to the boxcar loader.

If necessary, each size may be picked on its own boom before it is discharged into the transverse conveyor and then remixed before it is discharged into the boxcar loader. The advantage of this feature is that all combinations of sizes necessary to load in boxcars may be prepared at a relatively low installation cost.

The minus 1-5/8-size coal or slack is conveyed 200 feet below the tipple to the rescreen plant, where it is elevated and passed over a flexible shaker screen dividing it into pea coal or screened slack and dust. These two sizes fall into separate bins of 100 tons capacity. As the coal is wet from using water on the cutter bars and sprinkling, the flexible rapid shaker does not yield a dust-free screened slack. To improve this size of product, it is taken from the bottom of the bin by means of a belt conveyor and passed over a vibrating screen, after which it is essentially free from fines.

The dust is loaded from the bottom of the bin directly into railroad cars.

As mentioned before a crusher with two staggered rows of spikes is provided to split the product and reduce it to minus 3-inch size. All coal passing over the main feeder is run through a large, 36 by 72 inch, two-roll, adjustable crusher, which may be more properly termed "cracker". This cracker is adjustable from 8 to 21 inches and was installed primarily to break the enormous lumps loaded by the mechanical loaders in the mine to a size comparable to hand-loaded coal. It has been found, however, that this machine serves a useful purpose by permitting the operator to reduce all the production to minus 8-inch size during the summer months when there is little or no demand for plus 8-inch size.

After sizing, all the coal is picked by hand over flat picking tables. Mechanical units have been installed in Utah in only a few plants, and only for nut and screened-slack sizes.

All motors on the various units are push-button-controlled from a central booth. The operator in this booth can see every moving part in the tipple and by operating a master button can instantly stop every unit or can stop or start each individual unit as desired.

An average day's run is 1,600 tons, and the percentages of sizes produced are about as follows:

8-inch lump	20.00
Stove, 3 by 8 inch	32.00
Nut, 1-5/8 by 3 inch	15.00
Slack, minus 1-5/8 inch	33.00
Total	100.00

The tipple and rescreening plant are well-guarded throughout, lighting circuits are carried in conduit, and fire hydrants with ample hose afford fire protection for the surface plant and town.

Accumulations of fine coal and coal dust were noted in the tipple. A general periodical clean-up would minimize the hazard of coal-dust ignition. Open lights and smoking are prohibited in the tipple and rescreening plant.

Shop

A modern blacksmith and machine shop of wood and sheet-iron construction is maintained to make the necessary repairs to underground and surface equipment. The shop is kept clean and orderly, and wearing of goggles is compulsory when there is likelihood of encountering flying particles or material. This safety measure was adopted since the report made in January 1930 (to which reference has been made).

Lamphouse

The lamphouse is of stone, and about 50 feet left of the main portal. This building also serves as a checkroom and mine foreman's office. One hundred and fifty model E Edison cap lamps, with charging apparatus and permissible flame safety lamps, constitute the lamphouse equipment. The lamps are maintained in first-class condition by a lampman who is constantly on duty during the day. The flame safety lamps were likewise found in good condition.

Changehouse

A modern changehouse, equipped with an adequate number of hot and cold showers, is located near the tipple. The cleanliness of this building has not been neglected.

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Magazines

Main explosives magazine.- This magazine is of stone, well-located and naturally barricaded. About 1 carload of Hercoal C-1, 60 percent permissible explosive is usually stored in this magazine, which is kept free from trash and debris; no lights are permitted inside.

Distributing magazine.- The distributing magazine, of masonry construction, and naturally barricaded, is about 300 feet from the main magazine and approximately 200 feet from the main portal of the mine.

No to exceed 1 day's supply of explosives is kept in this magazine. The boxes of explosives are opened by wooden mallets and wedges. This magazine is also maintained in a neat, orderly condition.

Detonator magazine.- The detonator magazine is of masonry construction and is kept free of trash, etc. It is located well away from the other magazines and is naturally barricaded.

All magazines are equipped with heavy steel doors kept securely locked.

Fan

Since the previous Bureau report a new propeller-type Jeffrey fan has been installed at the portal of a short drift driven off the seventh left entry. The fan consists of 5 blades mounted on separate hubs, spaced for a distance of 5 feet along the propeller shaft. The fan operates in a cylindrical steel housing 6 feet in diameter and 5 feet long. It is driven by a 30-hp., 440-volt motor with Tyrex drive. The normal speed of the fan is 1,365 r.p.m., and it was exhausting 79,820 cubic feet of air per minute against 1-1/2 inches water gage. It is equipped with a Tycos automatic recording pressure gage.

The fan is placed at right angles to the drift, and a weak wall directly in line with the drift will relieve excess pressure in the event of unusual atmospheric disturbances within the mine. A substantial airlock provides ingress and egress into the fan drift without short-circuiting the air. If the fan stops signals are flashed at the main hoist and at a strategic point on the main haulage road.

The circuit breaker and oil switch are grounded and enclosed in fireproof housing. The entire installation is fireproof throughout. It is understood that the cost of this fan and accessories installation did not exceed $5,000.00.

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UNDERGROUND MINING CONDITIONS

Method of Mining

The mine is opened by a single rock slope, the portal of which is several hundred feet below the out crop of the coal. The rock slope intersects the coal at about 2,300 feet from the portal. From this point inby, parallel slopes were driven. The rock slope is well-timbered, and the pitch averages about 20 percent to the raise. The point of least elevation of the entire operation is the portal of the rock slope through which the entire output reaches the tipple.

Panel entries are turned right and left off the slope at 350-foot intervals, and rooms are turned off the panel entries on the up grade side only on 65-foot centers. The width of rooms is 28 feet, leaving 37-foot pillars between them. The width of entries averages about 16 feet.

All places are undercut by shortwall, electrically driven mining machines of both permissible and nonpermissible types.

Except for a limited amount of hand-loading the mine is entirely mechanized, three Goodman shovels and a Jeffrey pit-car loader being used. Electric drilling is employed.

Uniform pillar lines are maintained as far as possible, and on account of favorable roof conditions high extraction is possible, the recovery averaging about 95 percent. As a matter of fact, the greatest difficulty experienced in pillar work is to secure a roof break at the desired time, due to the fact that the roof of hard sandstone, is so exceptionally good that at times it stands unsupported over a considerable area.

Stoppings have been blown out in the past when caves occurred over large areas. When a situation of this kind arises it is watched closely, and every precaution is taken to prevent injury to the workmen.

Haulage

The coal is transported in 4-ton, all-steel, solid-body-type cars equipped with pin-and-link couplings, roller bearings, and safety chains. The cars are securely spragged and blocked while being loaded.

Horses attached to the cars by means of shafts and "guns" and trolley-reel locomotives are used for gathering purposes. All drivers ride the rear end of loaded cars; this practice has been adopted since the previous Bureau report. Trolley locomotives are used on main lines and operate on intake air only. The loads on the main entries are picked up from the partings by the raise hoist and lowered to the main parting located at the junction of the main raise and main slope. From this parting they are lowered to the outside by the main hoist and fed to the tipple by gravity.

The main hoist is equipped with regenerative braking. In some instances trips are pushed. All mechanically operated trips carry red reflectors instead of tail lights. It is understood that these reflectors are very satisfactory.

On the main slope parting there are two sets of safety "dogs" on the empty track to prevent the possibility of runaway trips. In addition there is a derail and an automatic switch. The loaded track is also equipped with a derail and an automatic spring switch.

Tracks are 42 inches gage and are well-maintained with respect to alinement, surfacing, and bonding. Both 20- and 40-pound rail is used. Slack coal and mine dirt are used for ballast.

Trolley wires are substantially supported from the roof, with a minimum distance of 6-1/2 feet above the rail. The height of the trolley wire above the rail apparently affords reasonable protection from contact and perhaps obviates the necessity for guarding the wire.

The men are carried into the mine on a man-trip and return to the surface via a well-kept manway, the portal of which is on the outcrop above the portal of the rock slope. All horses return to the surface following each shift, traveling the manway.

Sectional circuit breakers are used on trolley circuits. Rigid inspection from time to time prevents the likelihood of overfusing.

Timbering

Because of the extremely favorable roof conditions the necessity for systematic timbering in the advance workings is not apparent. A strict rule, however, requires that timber be set in working places when necessary. Considerable timber is used in pillar work, and where feasible the posts are set about 4 or 5 feet apart, or closer when necessary. Much of the timber is ultimately recovered, a Sylvester post puller being used to advantage. Substantial cap pieces of hewn material about 4 inches thick and 3 feet long are generally used.

Picks are used for roof-testing purposes. In spite of opinions to the contrary, the mine foreman with considerable underground experience has some excellent reasons in support of the use of such an implement for roof-testing purposes.

Good supervision at all times has kept accidents from falls of roof and coal to a minimum.

Lighting

Main haulageways, hoist stations, transformer rooms, partings, and substations are well-lighted with incandescent bulbs set in weatherproof, keyless sockets.

The mine is on a closed-light basis, the miners using permissible electric cap lamps. The firebosses make daily rounds of the mine, using permissible flame safety lamps.

UNDERGROUND ELECTRICAL EQUIPMENT

Power enters the mine at 2,300 volts, alternating current, in an armored submarine cable through the seventh left entry. The cable is carried on the floor and connects with the main hoist, the three transformer stations, and the substation.

The three transformer stations for converting 2,300 volts to 440 volts are up-to-date in every respect. Each consists of one bank of three units, circuit breakers, and oil switch. This equipment is adequately grounded and enclosed in a concrete housing with a steel door.

The doors are hinged at the top and held open by hemp ropes running over the transformers. Should the ropes be burned through the doors will close of their own weight and come to rest against concrete facings, which have an inclination of about 20° from the vertical. The floors are covered with about 6 inches of sand, and approximately 2 cubic feet of rock dust are kept near-by on the outby or fresh-air side.

The substation consists of two 2,300-volt (alternating current), 250-volt (direct current), 60-kw, motor-generator sets. The 250-volt direct-current circuit is used only by the locomotives.

The substation is of fireproof construction, an insulated platform insures safety when switches are operated, and a carbon tetrachloride fire extinguisher is kept in the station. The equipment is well-grounded, and the station is kept neat and clean.

All underground electrical equipment, except the main hoist and the locomotives, operates on 440 volts, alternating current. The main hoist uses 2,300 volts, and the locomotives use 250 volts, direct current.

All trailing cables of cutting and loading machines are connected to the source of power by means of receptacles. The receptacles, when in use, are substantially anchored to posts, so that when tension comes on the trailing cable the sections will not become disconnected. Secondary cables running to the various workings are laid on the floor next to the rib.

The principal electrical equipment is as follows:

1	Raise hoist, single-drum, 440-volt, 250-hp.
1	Main hoist, Vulcan, single-drum, 2,300-volt, 300-hp.
3	Goodman shovels.
1	Pit-car loader.
6	Undercutting machines, Sullivan C.E. 7.
1	Undercutting machine, Sullivan, permissible, C.R. 3.
1	Undercutting machine, Goodman G-3.

Both the raise and main hoists are well-guarded, kept clean, orderly, and well-lighted, and protected by carbon tetrachloride fire extinguishers.

Telephones are installed at the hoists and at other strategic points in the mine.

Voltage on the signal lines is 110 alternating current at the source but has dropped to about 75 volts by the time it actually reaches the signal wires. It would appear that a much lower voltage could be used as effectively with reduced shock hazard.

EXPLOSIVES AND BLASTING

Hercules permissible explosive, Hercoal C-1, 60 percent, 1-1/2 by 8 inches, and No. 6 instantaneous and first-delay detonators are used in the blasting operations.

The explosives are placed in canvas bags in an insulated box on the surface, and the box transported into the mine in an empty car. The box is taken from the car at a convenient point, and the explosives are distributed to the various working places by a man specially assigned to that duty. Detonators are carried into the mine by a shot firer.

Both miners and shot firers load the holes. The permissible limit of 1-1/2 pounds is not exceeded. Adobe is used for stemming and is tamped to the collar of the hole with wooden tamping bars.

After the shift is out of the mine the shot firers wire all shot holes in parallel and connect them to the firing circuit. All shots are fired from the outside, using 130 volts alternating current. The main shot-firing circuit is of No. 6 wire 2 miles long. No. 10 wire is used on the entries and No. 14 wire in the rooms. Detonator legs are of iron 8 feet long.

Due to good connections in the circuit and the practice of wiring all shots in parallel, missed shots are of rare occurrence. Missed holes are shot with a battery. After all shots are wired the shot firers proceed to the surface, closing the place and section switches. The shots are then fired from the surface by closing the master switch, located near the fan, after all men are out of the mine. All men are checked in and out of the mine, and the shot firers make sure that all men are out of the mine before the master switch is closed. The master switch and section switches are kept locked when not in use. The section switches are of the safety type, fused and mounted on iron brackets set in the roof and all grounded to the roof.

Much improvement was noted in the condition of the blasting circuit since the last report. Every precaution is taken at places where this circuit crosses others.

Only 1 day's supply of explosives is permitted in the mine, and any surplus is returned to the magazine by the shot firers before the shift enters the mine.

Ventilation

The mine is well-ventilated on the split system by the propeller fan previously described in this report. At the time of the inspection the fan was exhausting 79,820 cubic feet of air per minute against 1-1/2 inches water gage.

The oxygen content was over 20 percent in all the air samples taken, which indicates, from a health standpoint, that the mine is adequately ventilated.

Air enters the mine through the main portal, and the 7th left and 15th right, and inasmuch as these three openings are at the two extremities and the middle of the mine it becomes a comparatively simple matter to supply fresh air to all parts of the mine. The live workings are concentrated due to mechanization and are confined to the 12 left, 14 and 15 rights and to the raise sections off 15 right.

Stoppings are constructed of coke breeze-cement blocks which are recovered as the pillars are drawn and used again and again. The stoppings are hitched into the ribs, roof, and floor and were found exceptionally free from leaks. Overcasts are of reinforced concrete.

Doors are used to very limited extent and are constructed of a double thickness of 1-inch boards on 2x4-inch framing.

No line canvas is used; however, some curtains are required to deflect the air properly into some of the pillar sections.

Air Samples

Six air samples were taken at five different points during this examination; the laboratory analyses are shown in table 1. Bottle numbers of the samples are written on the map at the points taken. All samples showed the presence of methane in relatively small amounts, ranging from 0.02 to 0.07 percent. Although those amounts are far too small to be detected by a flame safety lamp the fact remains that methane is present, which indicates the possibility that larger quantities of gas may be given off at some future time. This possibility, remote as it may appear, is realized by the management as evidenced by the fact that efficient fireboss inspection, coupled with good, measurable ventilation are considered prerequisites to the safe and economic operation of the property.

TABLE 1. - Air analyses of Liberty Fuel Co. Mine, Latuda, Utah

Collectors:
D. J. Parker and W. W. Kessler

December 13, 1933

Bottle no.	Location in mine	Carbon dioxide percent	Oxygen percent	Methane percent	Volume of air, cu. ft. per min.	Methane volume, per 24 hours
121	Face, 15 right raise, back entry	0.28	20.43	0.03	-	-
122	Face, 15 right raise, main entry	.27	20.38	.02	-	-
135	Face, 14 right, back entry	.29	20.51	.03	-	-
136	Face, 14 right, main entry	.16	20.79	.07	-	-
137	Main return, 50 feet inby fan	.18	20.72	.03	79,820	34,482
138	do.	.16	20.70	.02	79,820	22,988

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Duplicate samples (bottles 137 and 138) taken in the main return had a methane content of only 0.03 and 0.02 percent, respectively, in 79,820 cubic feet of air per minute. Insignificant as these quantities may appear, they amount to 34,482 (bottle 137) and 22,988 (bottle 138) cubic feet of pure methane every 24 hours. Even the smaller quantity of methane, if diluted to its maximum explosive point of approximately 10 percent, would equal 229,880 cubic feet of explosive mixture every 24 hours. If the fan were stopped for 24 hours, assuming there was no natural ventilation, enough gas would accumulate to fill 3,284 feet of a 7- by 10-foot entry with a maximum explosive mixture.

The oxygen content of each of the six samples was above 20 percent and only slightly below that of normal air. Ordinary clean dry air contains 20.93 percent of oxygen by volume.

The carbon dioxide (CO_2) content of the six samples was correspondingly low and ranged from 0.16 to 0.29 percent. Normal dry air contains 0.03 percent carbon dioxide.

Humidity

Moisture conditions were generally good throughout the mine. As a matter of fact, the number of dust samples collected was limited by the moist condition of floor and ribs.

Water is used for sprinkling working places, including ribs, roof, faces, and coal piles, and is applied in generous quantities to all cutter bars. Each working place is piped with 3/4-inch water lines and provided with hose and suitable connections.

United States Bureau of Mines tests show very definitely that Utah coals will not absorb enough moisture to prevent the propagation of an explosion; but if kept sufficiently moistened, dust will not get into the air, and the chances for initiating an explosion will be minimized.

Drainage is good because all workings lie above the portal.

Rock Dust

Gypsum dust, applied by hand and machine, is used throughout the mine. All open, accessible workings, including rooms, entries, aircourses, crosscuts, slopes, and manways have been rock-dusted. Working places are rock-dusted up to within 30 or 40 feet of the face or up to the watered zone. As the faces advance the rock-dusting is extended. Contrary to expectation, the gypsum dust apparently showed very little tendency to cake.

During this examination 14 dust samples were taken at 7 different points in the mine. The results of the analyses of the samples are shown in table 2.

TABLE 2. - Dust analyses of the Liberty Mine, Liberty Fuel Co., Latuda, Utah

Collectors: D. J. Parker & W. W. Kessler

Can number	Location in mine	Kind of dust	Analyses on an "as received" basis, percent			Total incomb. moisture plus ash	Cumulative percent through mesh		
			Moisture	Ash	Comb.		48	100	200
H-664	Bottom, 15 right raise	Road	8.3	39.1	52.6	47.4	59.3	36.1	22.9
P-953	do	Rib & roof	16.8	75.2	8.0	92.0	85.2	57.8	40.4
H-715	15 right entry, 2,700' from slope	Road	9.2	61.5	29.3	70.7	68.5	46.8	30.4
H-741	do	Rib	17.1	73.0	9.9	90.1	91.1	87.6	53.4
H-738	14 right back entry, 1,800' from slope	Road	10.4	39.1	50.5	49.5	68.7	40.4	25.2
H-701	do	Rib	16.0	67.1	16.9	83.1	83.2	54.3	32.1
D-859	14 right main entry, 1,800' from slope	Road	15.6	61.4	23.0	77.0	78.9	55.1	36.3
H-722	do	Rib	17.3	77.5	5.2	94.8	94.5	73.6	51.7
H-697	14 right main entry, 300' from slope	Road	14.8	59.6	25.6	74.4	73.3	44.8	27.3
H-705	do	Rib & roof	18.4	75.1	6.5	93.5	87.0	61.1	35.8
H-739	12 left, 600' from slope	Road	5.6	75.0	19.4	80.6	65.6	41.7	27.7
H-728	do	Rib & roof	18.4	72.2	9.4	90.6	86.5	61.9	36.5
H-537	12 left, 50' inby first raise	Road	8.1	50.5	41.4	58.6	56.5	31.3	18.8
H-707	do	Rib & roof	19.1	71.2	9.7	90.3	82.4	60.8	30.8

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Of the 14 samples collected only 3 showed a total incombustible content (moisture plus ash), below 70 percent. The inert content of these 3 samples ran 47.4, 49.5, and 58.6 percent. The can numbers of these 3 substandard samples, all of which are road dust samples, are H-664, H-738, and H-537. Attention is directed to the fact that the 3 corresponding rib- and roof-dust samples showed an incombustible content ranging from 83.1 to 92.0 percent.

As a matter of general information, Bureau of Mines tests show that to prevent the propagation of an explosion by Utah coals at least 70 percent inert material should be present when no methane is present, and 75 percent when 1 percent of methane is present.

Furthermore, experiments conducted in 1925 by the Bureau of Mines on the explosibility of Utah coals show that the principal factors determining the explosibility of the dust are: Fineness, ratio of volatile matter to volatile matter plus fixed carbon $\left(\frac{\text{V.M.}}{\text{V.M.+F.C.}}\right)$, and percentage of incombustible matter present.

Coal dust passing through 20-mesh is likely to be explosive. Its relative sensitiveness is increased by the amount of finer-than-20-mesh. The ratio of the volatile matter to the total combustible, $\frac{\text{V.M.}}{\text{V.M.+F.C.}}$, is an index to the ease of explosibility of the dust; other factors being equal, the higher the volatile-combustible ratio, the more easily is the dust ignited.

The analysis of a composite sample of coal from the Liberty mine runs as follows:

Moisture - - - - -	4.6	
Volatile matter -	43.9	
Fixed carbon - - -	45.9	B.t.u. - 13,050
Ash - - - - - - - -	5.6	
	100.0	

The volatile-combustible ratio based on this analysis is 0.49. This high ratio is typical of Utah coals and indicates very definitely that the dust is easily ignited.

The only reliable method of determining whether or not a mine is adequately rock-dusted, with respect to the quality of the dust, is to have a competent person analyze a representative number of samples. Basing conclusions on the results of the analyses of samples taken during this examination, it is felt that the Liberty mine measures up to the requirements of a well-rock-dusted mine, with respect both to the quality of the dust and the extent of its distribution. Notable progress has been made in the matter of rock-dusting during the past 3 years.

SAFETY EDUCATION AND REQUIREMENTS

Hard hats and hard-toed shoes are compulsory, both underground and on the surface, and goggles are required to be worn whenever there is likelihood of encountering flying material or particles; this includes the rope rider.

A safety committee composed of the superintendent, mine foreman, superintendent of the Spring Canyon Mine Rescue Association, the chief clerk, one man from the outside, one man from the haulage, one man from the miners, and one man from the mechanical department, meet monthly for the purpose of formulating safety rules and discussing any accidents that may have occurred during the preceding month. Mass safety meetings are held from time to time.

One-hundred percent first-aid training was completed in November 1931 and again in December 1933. Twenty-one of the employees, including the mine foreman who has taken the course twice, have completed the Bureau of Mines Accident-Prevention Course.

The Liberty Fuel Co. is a member of and contributor to the Spring Canyon Mine Rescue Association. Several employees have been trained in the use of oxygen breathing-apparatus.

Electric safety signs are installed at appropriate locations in the mine and are quite conspicuous due to their intermittent lighting effect. Direction signs are also posted pointing the way to the exits.

The mine foreman is perhaps one of a few men in that position who holds to the doctrine (and rightly so) that a large share of the responsibility for accidents rests upon the company officials generally and upon the mine foreman in particular. Such an attitude, it is believed, cannot fail to produce the desired results in preventing accidents.

SAFETY ACCOMPLISHMENTS

In 1933 an average of 80 men employed at the Liberty mine, working 121,533 man-hours, produced 102,945 tons of coal with 7 lost-time accidents, entailing a loss of 81 days. The frequency rate was 57.5 and the severity rate 0.66.

The employees are divided into groups, each competing for the best accident record. Each year the company awards a suitable prize and gives a banquet for the winning group. The group designated as inside day men won the contest for 1933. This group, comprising 27 men, as of December 31, 1933, had worked 637 days or 68,172 man-hours without a lost-time accident. The last fatality at this mine occurred to a member of this group on February 4, 1932.

RECOMMENDATIONS

The Liberty Fuel Co. is to be commended for the progress it has made during the past few years in matters pertaining to safety, including the installation of an up-to-date fan.

During the course of the examination reported in this paper a few conditions were noted, which in the interest of safety might be improved upon. The following suggestions are, therefore, offered in the spirit of helpful cooperation:

1. Roadways should be rerock-dusted where substandard conditions exist with respect to the incombustible content.

2. As much coal dust as possible should be removed from the tipple. This might best be accomplished in winter by sweeping out the tipple with a stiff broom, although in the absence of freezing weather there appeared to be no reason why the tipple could not be thoroughly washed down with fire hose, assuming, of course, that the electrical equipment could be properly protected from the moisture.

3. Voltage on the signal lines might well be reduced to a point not to exceed 35 volts.

4. In the replacement of electrical equipment for underground use consideration should be given to the permissible type.

5. At least two crews of apparatus men should be kept thoroughly trained.

6. As a means of furthering and maintaining interest in safety, mass safety meetings should be held at regular intervals.